Quantum State Tomography with Conditional Generative Adversarial Networks

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Abstract

Quantum state tomography (QST) is a challenging task in intermediate-scale quantum devices. Here, we apply conditional generative adversarial networks (CGANs) to QST. In the CGAN framework, two dueling neural networks, a generator and a discriminator, learn multimodal models from data. We augment a CGAN with custom neural-network layers that enable conversion of output from any standard neural network into a physical density matrix. To reconstruct the density matrix, the generator and discriminator networks train each other on data using standard gradient-based methods. We demonstrate that our QST-CGAN reconstructs optical quantum states with high fidelity, using orders of magnitude fewer iterative steps, and less data, than both accelerated projected-gradient-based and iterative maximum-likelihood estimation. We also show that the QST-CGAN can reconstruct a quantum state in a single evaluation of the generator network if it has been pretrained on similar quantum states.